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THE IMPACT OF HOLOCENE CLIMATE ON THE DEVELOPMENT OF PREHISTORIC SOCIETIES IN SOUTHERN SIBERIA

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ABSTRACT. Geochemical data of ^{10}Be, ^{14}C, δ^{18}O obtained from natural archives (tree rings, ice sheets, varves, corals) indicates that the climate during the Holocene was not stable. The cosmogenic isotope fluctuations are bound by the periodicity on solar activity and climatic changes. The sharpest and most abrupt climatic deteriorations are registered in the Early and Middle Holocene at 8200, 5800, 5400, 4300, and 2800 cal BP. These events are characterized by cold conditions. The impact of climate on human communities in steppe depressions in southern Siberia (Nazarovo, Minusinsk, and Turano-Uyuk) was noticeable. The differences of local landscape-climatic conditions in these depressions were connected with global climatic changes to determine the processes of occupation, development, and migrations of ancient societies during the Neolithic, Bronze Age, and Iron Age. The chronology of archaeological cultures was also correlated with the local and global climatic changes during the Early and Middle Holocene in southern Siberia. Here, we generalize the literature data about Holocene climatic changes and archaeological cultures in the southern Siberia region.

INTRODUCTION

Climatic fluctuations influenced the development of prehistoric societies. The Holocene period had one of the most favorable climates in human history. Recent investigations, however, have shown that this period was characterized by global climatic fluctuations connected with solar activity (see van Geel et al. 1998, 1999; Dergachev et al. 2003; Dergachev and van Geel 2004). Strong fluctuations of solar activity are recorded via cosmogenic isotopes like ^{14}C and ^{10}Be from different natural archives. Dergachev and van Geel (2004) conducted a spectral analysis of the non-stationary behavior of high-precision radiocarbon data observed in tree rings (Stuiver and Becker 1993) over the past 8000 yr and showed that cyclic climatic variations with a duration of about 2400 yr and 1500 yr are caused by changes in solar activity. The cosmic rays produce cosmogenic isotopes ^{10}Be and ^{14}C in the Earth's upper atmosphere by bombarding atomic nuclei. The isotopes accumulated in different natural archives, such as tree rings, ice cores, corals, and lacustrine deposits with cycles of 2400 yr, and a less precise cycle of 1500 yr.

Evidence of Holocene climate variability and solar forcing on the climate has been apparent from natural archives. Patterson et al. (2004) noted the coeval fluctuation in the production rates of the cosmogenic nuclides ^{14}C and ^{10}Be, and annual to millennial timescale changes in globally distributed proxies of drift ice suggest that celestial forcing plays a dominant role at centennial- (~200–500 yr) and millennial-scale (1000–1500 yr) Bond cycle frequencies. The latest research on sea surface temperature (SST) in the northwestern Pacific off central Japan during the Holocene has found evidence of a regular pacing at 1500-yr intervals seen throughout both the Holocene and the last glacial period. This assumed oscillation was a response to external forcing (Isono et al. 2009). Recent high-resolution analyses of lake sediment from SW Alaska showed evidence of cyclic variations in climate and ecosystems during the Holocene (Hu et al. 2003). These variations occurred with periodicities similar to those of solar activity and appear to be coherent with time series of the cosmogenic nuclides ^{14}C and ^{10}Be as well as North Atlantic drift ice. Roth and Reijmer (2005) argue for the 260-, 380-, and the 500–600 yr quasi-periodic signals, which are found to be of climatic origin, whereas the millennial-scale fluctuations remain enigmatic, although solar forcing mechanisms seem likely. According to Bard and Frank (2006), the solar fluctuations were involved in causing widespread but limited climatic changes, such as the Little Ice Age (AD 1500–1800).

Although the casual relationship between solar activity and climate is still poorly understood at present because other factors in addition to solar activity influence the climatic records, the comparison of radionuclide and climate records provides increasing evidence for an important influence of solar activity changes on the climate during the Holocene (Mayewski et al. 2004). Magny (2004) supported the hypothesis suggested by Denton and Karlén (1973) that the residual ^{14}C record in tree rings may be an empirical indicator of Holocene paleoclimate. According to Dergachev (Dergachev and van Geel 2004; Dergachev et al. 2007), the increase of ^{14}C concentration in tree rings shows the cyclic variations and marks the episodes of solar activity decrease and the cold climatic events. These cold phases were locked in oxygen isotopic fluctuations from the Greenland ice cores and other climatic proxy records (Bush 2005). They are characterized as very cold short phases. Many of these changes are sufficiently fast from the point of view of human civilization (i.e. a few hundred years and less) and so may be considered "rapid" (Mayewski et al. 2004). According to numerous studies, the global episodes of falling temperature synchronous with a period of low solar activity after the Younger Dryas (12,700–11,500 cal BP) were recorded at 8200 cal BP (Magny et al. 2003; Heiri et al. 2004; Kofler et al. 2005), at 5800 and 5300 cal BP (Magny and Haas 2004); ~4100 cal BP (An et al. 2006; Chen et al. 2006); at 2800 cal BP (van Geel et al. 2004; van Geel and Beer 2007); and around 500 cal BP. The calibrated ages of these brief cold periods coincide with ^{14}C cosmogenic isotope anomalies, which are characterized by "plateaus" on the calibrated curves.

Model experiments by Goosse et al. (2002) show that the fluctuations in solar activity have been responsible for the decrease of thermohaline convection in oceans and expansion of polar atmospheric flows in the both hemispheres. It was assumed by Mullins and Halfman (2001), Lamy et al. (2002), Magny et al. (2003), and Herzschuh (2006) that these processes weakened the African and Asian monsoons due to the temperature decrease and the thermal contrast between land and oceanic air masses. On the other hand, the thermal gradient shift between high and low latitudes was registered. Hence, latitudinal shifts in the position and strength of the Westerlies accounted for the humid conditions in high and low latitudes. Some regions in southern Siberia and central Asia are located in the zone of Westerlies' influence. The territories in southern Siberia and central Asia are inner areas with continental climatic conditions, and are divided by mountain ridges into several depressions. This region is characterized by strong climatic differences, especially concerning effective moisture. The Tibetan Plateau, northwestern and north-central China, Mongolia, and southern Siberia are situated in the triangle of the Indian Monsoon, the Southeast Asian Monsoon and the Westerlies (Figure 1) (see Yu et al. 2006). Therefore, reconstructing the climate during the Holocene in southern Siberia and central Asia is a difficult task. During sharp cold events, the monsoonal circulation became weaker, but the Westerlies were shifting to the north and some areas of southern Siberia were under humid conditions. Such geographical features in this territory influenced the settlement of people and their social and economic structures. The appearance and expansion of prehistoric people in the depressions differed depending on the local climatic and landscape conditions. This paper presents information about the chronology of ancient cultures and the climatic fluctuations in different regions of southern Siberia, considering the impact of global climatic events on the cultural processes and migrations of prehistoric people. ^{14}C analysis was used as the instrument for correlation of archaeological and environmental events.

DESCRIPTIVE BACKGROUND AND METHODS

Southern Siberia comprises the intermountain depressions within the Altai and Sayan mountain systems. A chain of isolated depressions belonging to the ancient steppe belt in the center of Asia extends from Siberian temperate forests in the north to the desert and semi-desert depressions of NW Mongolia. Prevailing dry conditions determine the poor organic deposition and low accumula-

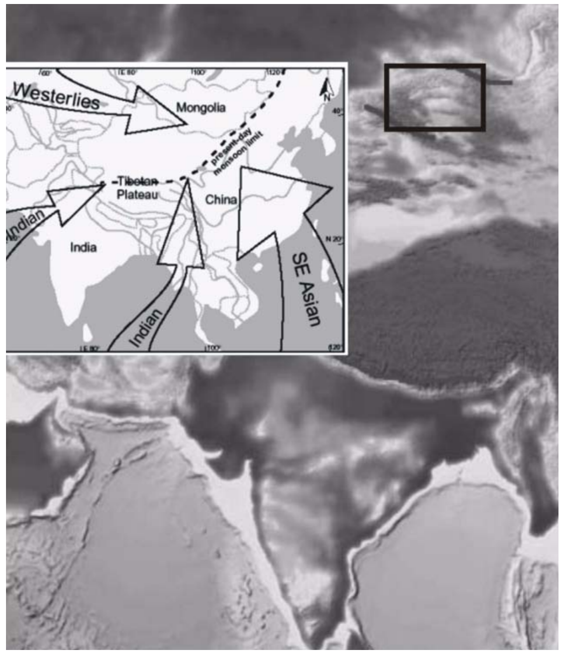

Figure 1 Region of southern Siberia and the distribution of air flows in Asia according to Yu et al. (2006).

tion rates in the region that prevent obtaining high-resolution records and their reliable chronology. Climatic changes during the Holocene and cultural processes were studied for the depressions Nazarovo, Minusinsk, and Turano-Uyuk (Figure 2). In this paper, all literature data on Holocene climatic changes and archaeological cultures in southern Siberia region are generalized.

The Nazarovo depression is located between the low-altitude mountain ridges Arga, Solgonskiy, and Batenevskiy. It borders a flat region of the Chulym River basin and the taiga of western Siberia. The depression is hilly with flat river valleys. The modern summer temperature is 16–18 °C, and the mean winter temperature is –16 to –20 °C. These conditions characterize the temperate nature of the climate. In the depression, there are different types of landscapes: steppes, light forests, birch groves, floodplain, and bogs. To reconstruct the climatic conditions of the Holocene, deposits from Popovo Lake and paleosol from barrow 1 from the Beresh site near Sharipovo City were sampled and analyzed. Mineralogical-geochemical methods and ^{14}C analysis were used. The results were published recently (Kulkova and Krasnienko 2008, 2010). The mineralogical-geochemical methods for Holocene climatic reconstructions were published elsewhere (Chen et al. 1999; Koinig et al. 2003; Parker et al. 2006; Minyuk et al. 2007; Schwamborn et al. 2008). The most sensitive paleoclimatic markers determining the humid and cold climatic conditions of this region during the Holocene were used: TOC (total organic carbon) concentration, CIA (chemical index alteration of Nesbitt and Young; see Jahn et al. 2001), CaO/MgO ratio, and the mineralogical types of clay. The buried soils and their ages, determined by ^{14}C analysis, are another indicator of climatic changes.

The Minusinsk intermountain depression located north of the Sayan Mountains includes the Republic of Khakassia and the southern part of Krasnoyarsk Province (Figure 2). This is one of the largest depressions in southern Siberia. The climate is very continental with large seasonal temperature variations over 50 °C and a temperature inversion in winter. Forest-steppe exists at the outer areas

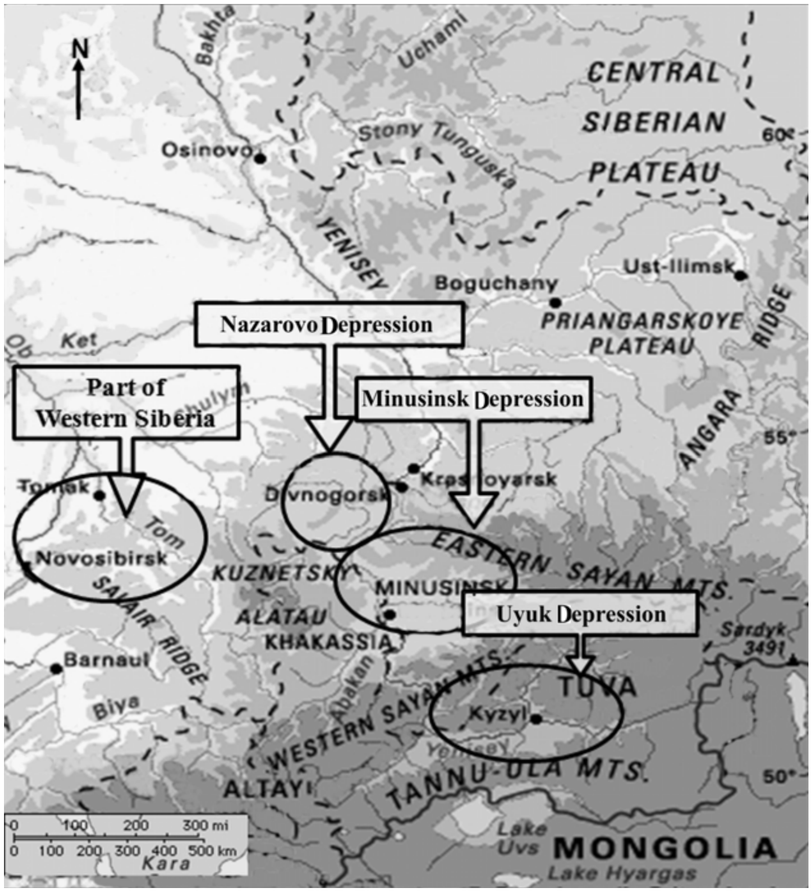

Figure 2 The main depressions of southern Siberia

of the depression from the foothills up to 700–1000 m elevations. The deposits from some freshwater lakes—Kutuzhekovo (53°36′N, 91°56′E), Big Kyzykul (53°36′N, 91°56′E, 320 m asl), Shushenskoe (53°19′N, 92°03′E, 300 m asl)—and Tepsey loess cross-section (53°59′N, 91°33′E) were sampled. For climatic reconstructions of the Minisinsk depression, pollen analysis, geochemical indicators of paleoclimate, and ^{14}C dating were applied (Kulkova 2004, 2005; Zaitseva et al. 2005; Dirksen et al. 2007a,b). The most significant features of cold and humid episodes were determined in pollen spectra by decreasing of frequency of xerophytic taxa like *Artemisia* and Chenopodiaceae, the sharp rise of Cyperaceae, the high frequency of tree pollen, and the characteristics of pine pollen species. Simultaneously, the deposits formed during these episodes are characterized by increasing TOC, and CIA, and C/N ratio parallels the considerable decrease of carbonates.

The southern part of the Turan-Uyuk depression is surrounded by the Sayan Mountains to the west and east and by the Uyuk mountain ridge to the south with an altitude of 1800–2300 m asl. The present climate is extremely continental with an annual temperature amplitude of 50 °C. Annual precipitation is ~300 mm. The Tuva intermountain depressions are characterized as open steppe.

For climatic reconstruction, the multiproxy indicators from deposits of freshwater White Lake-2 and buried eolian sediments from the Arzhan-2 barrow were used. Pollen analysis, geochemical indication of paleoclimate, and ^{14}C dating methods were applied. The results were published in a series of articles (see Kulkova 2004, 2005; Zaitseva et al. 2005; Dirksen et al. 2007a,b). The transition to cold and humid conditions is marked by the colonization of grasses and sedges on the lake shores, the replacement of halophytic communities by hygrophilous types, the increase of shrub birch pollen, the predominance of TOC in comparison with carbonate and sulfate complexes, and C/N ratio increase. Chironomid data from some lakes of Tuva (Ilyashuk and Ilyashuk 2007) indicate that inferred climatic changes and the major climatic events (the last glacial-interglacial and the Late Glacial–Holocene transitions, B/A, Younger Dryas, 8.2 cal kyr BP, and Neoglaciation) marked in many records from both hemispheres imply that the events throughout the post-glacial climatic history of southwestern Tuva were generally non-local appearances.

The transition periods between warm and cold and dry and humid phases were determined on the basis of relative variations of climatic indicators (Zaitseva et al. 2005; Dirksen et al. 2007a,b). Figure 3 shows the chronology of climatic fluctuations for each depression. For comparison, the data on climatic changes in the southern area of western Siberia were used (Orlova and Zykina 2002; Orlova et al. 2007; Bezrukova et al. 2008). The periodization and chronology of ancient cultures of that territory have been studied thoroughly (Vadetskaya 1986; Bokovenko 1997; Krasnienko and Subbotin 1997; Erlich 1999; Gryaznov 1999; Alekseev et al. 2001, 2005; Chugunov et al. 2001, 2006, 2007; Görsdorf et al. 2001, 2004; Vasiliev 2001; Krasnienko 2002, 2003; Vdovina 2004; Zaitseva et al. 2004, 2005). Table 1 presents the chronological boundaries of archaeological cultures from different parts of southern Siberia based on archaeological and ^{14}C data. The conventional ^{14}C dates were calibrated using the OxCal v 3.10 program (Bronk Ramsey 1995, 2001) and the IntCal04 calibration curve (Reimer et al. 2004).

RESULTS AND DISCUSSION

The general scheme of environmental changes and development of archaeological cultures during the Early to Middle Holocene was constructed (Figure 3) on the basis of climatic reconstructions for southern Siberia. It is noteworthy that the major cold and humid events agree with global climatic events (Figure 3). Social adaptations varied in the degree of abruptness, magnitude, and duration of climate changes in different parts of region.

The Mesolithic and Neolithic cultures (8th–4th millennia BC) were not numerous in the intermountain depressions of southern Siberia. The Neolithic cultures developed in western Siberia and the Nazarovo depression at ~8200 cal BP (~6250 cal BC). At that time, the Neolithic societies had just appeared in Uyuk and Minisinsk depressions (Lisitsin 1988). A layer with Neolithic artifacts from a cave situated near Kuilug-Khem River dates to 7670–7480 cal BP (5720–5530 cal BC). The climatic conditions at ~8200 cal BP were cold and humid; this event was a short-term period. After that, the climate became more dry and warm until ~6300 cal BP (~4350 cal BC) when the climate changed again to a short and abrupt cold/humid event, which lasted from 300 to 600 yr in different areas of southern Siberia. The next period was more dry and warm. Thus, the 2 short cold/humid abrupt climate changes during the Early Holocene are recorded in southern Siberia. Evidently, dry and warm climatic conditions were one of the reasons for the presence of a small number of the Mesolithic–Neolithic sites in the southern steppe zone. Occasional Neolithic artifacts were found only in the piedmonts. Ancient people presumably occupied the favorable ecological niches during the wettest episodes. At the end of Neolithic, people began to settle in the depressions of the Middle Yenisei region, evidenced by the rare archaeological finds and thin cultural layers in the steppe lakes of Khakassiya. The southern taiga and forest steppe zones of western Siberia were occupied by Neolithic communities and later by Aeneolithic and Early Bronze Age settlers.

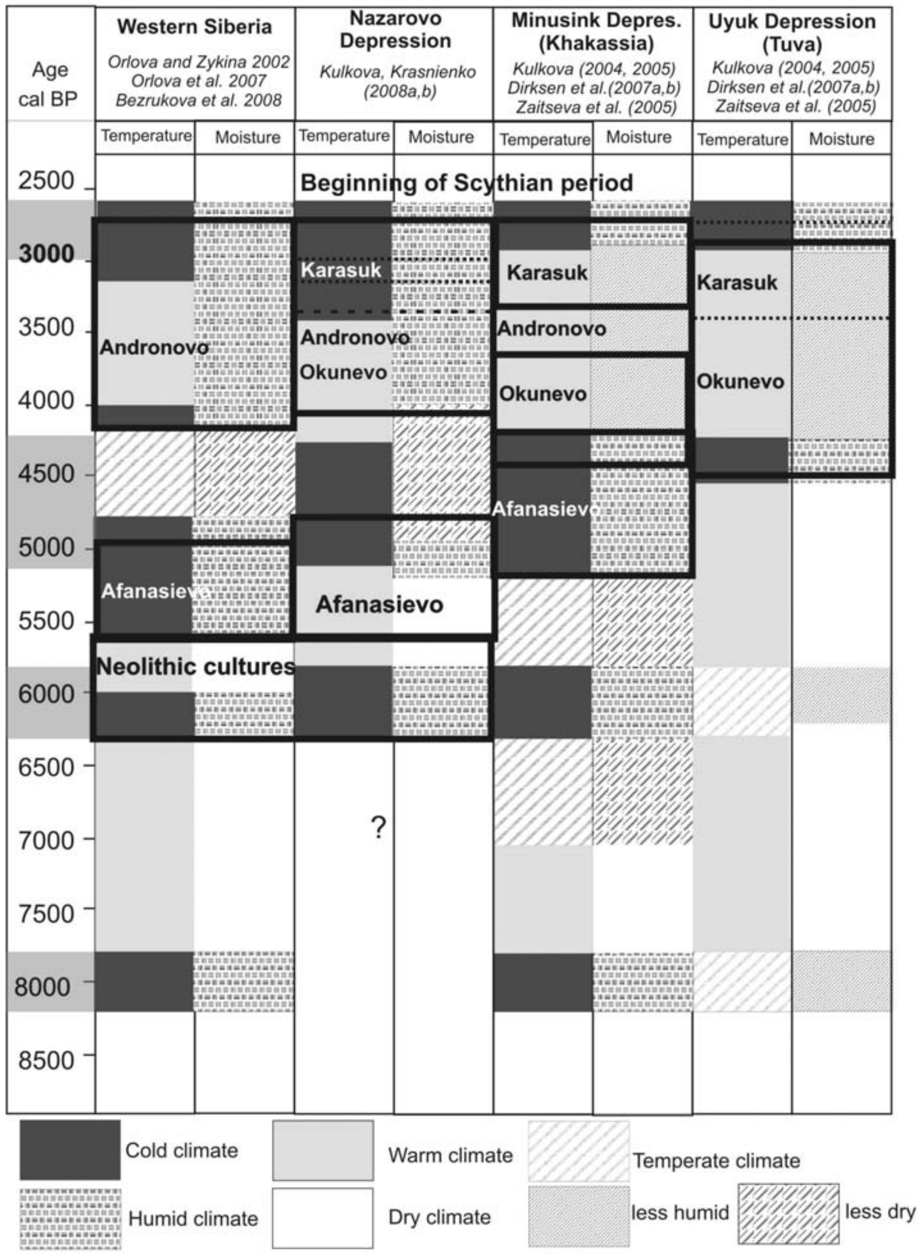

Figure 3 General scheme of climatic changes for each depression and development of archaeological cultures during the Early–Middle Holocene in southern Siberia and southern part of western Siberia.

The active occupation of southern Siberian steppe lasted from 5950 to 4950 cal BP (4000–3000 cal BC). In the Nazarovo depression, cool and humid conditions were recorded at ~5200 cal BP (~3250 cal BC). The Afanasievo culture, which featured the first barrow (*kurgan*) complex of the region and the most eastern one in the system of Indo-European nomadic groups, appeared in this area at ~5550 cal BP (~3600 cal BC). This was a stockbreeding culture that used metal (copper) (Vadetskaya 1986).

Table 1 Chronological boundaries of archaeological cultures from different parts of southern Siberia.

Calendar ages (± 2 σ) cal BC (cal BP)	Culture	Region	References
8000–4000 (9950–5950)	Mesolithic–Neolithic	Eurasia	Vasiliev (2001)
6250 (8200)	Neolithic	Western Siberia, Nazarovo depression	Krasnienko (2003)
5720–5530 (7670–7480)		Tuva, Kuilug-Khem Cave	Semenov (2004)
4000–3000 (5950–4950)	Eneolithic–Early Bronze Age	Southern Siberia	Dirksen et al. (2007)
3600 (5550)	Afanasievo	Nazarovo depression	Krasnienko (2002)
3640–3550 (5590–5500)	(beginning)	Western Siberia	Vdovina (2004)
3340–2900 (5290–4850)	Afanasievo (end)	Minusinsk depression	Görsdorf et al. (2004)
2500–2290 (4450–4240)			
3800–2900 (5750–4850)	Afanasievo	Altai Mountains	Gryaznov (1999)
2620–2460 (4570–4410)	Okunevo (beginning)	Minusinsk depression	Görsdorf et al. (2004)
1920–1730 (3870–3680)	Okunevo (end)		Krasnienko (2002)
			Dirksen and Chugunov (2007)
1800–1300 (3750–3250)	Okunevo	Nazarovo depression	
1320–1130 (3270–3080)		Uyuk depression	
1920–1730 (3870–3680)	Andronovo (beginning)	Minusinsk depression	Görsdorf et al. (2004)
	Andronovo (end)		
1500–1395 (3450–3345)	Andronovo		
		Nazarovo depression	Krasnienko (2003)
1800–1400 (3750–3350)			
1400–1300 (3350–3250)	Andronovo (end)	Yenisei River	Erlich (1999)
1320–1120 (3270–3070)	Karasuk (beginning)	Minusinsk depression	Görsdorf et al. (2004)
1020–810 (3870–2760)	Karasuk (end)		
1300–1100 (3250–3050)	Karasuk	Nazarovo depression	Krasnienko (2003)
810–730 (2760–2680)	Tagar (beginning)	Minusinsk depression	Görsdorf et al. (2004)

Among the Afanasievo sites in the Nazarovo depression, there are not only kurgans but settlements such as Oraki, Ashkil, and Glyadel VIII (Krasnienko 2002). In the Altai region, according to Gryaznov (1999), the Afanasievo sites date to 5750–4850 cal BP (3800–2900 cal BC). The earliest date of the wooden grave Elo-I from the Ongudai district in the Altai Mountains is 5590–5500 cal BP (3640–3550 cal BC). In the southern Minusinsk depression, the phase of cool and moist climate culminated at ~5200 cal BP (~3250 cal BC). The bearers of Afanasivo culture expanded in this region during 5290–4850 cal BP (3340–2900 cal BC). At that time, the intermountain depressions of Tuva located in the southernmost part of the region were sparsely populated; sites of the Afanasievo culture were not founded. In the Tuva region, the climate still remained very warm and dry. Evidently, Nazarovo and Minusinsk depressions were occupied by people of Afanasievo culture due to an increase in humidity. The dry climatic conditions of Turan-Uyuk depression in that period hindered human existence. The dry steppes were not suitable for stockbreeding.

The Afanasievo culture was replaced by the Okunevo; both complexes coexisted for some time. The bearers of Okunevo culture occupied the steppe of Minusinsk depression from 4570–4410 cal BP (2620–2460 cal BC) to 3870–3690 cal BP (1920–1740 cal BC). The existence of this culture in the Turano-Uyuk depression is recorded until 3270–3080 cal BP (1320–1130 cal BC). Maximum humidity in this depression is recorded at 4500–4200 cal BP (2550–2250 cal BC). The climate of Minisinsk depression was humid and cold, while in the Nazarovo depression and in the southern part of western Siberia the conditions were less humid. In the Nazarovo depression, the amount of Okunevo sites is much smaller than south of this area. They were attributed to 3750–3250 cal BP (1800–1300 cal BC). According to data from the Okunevo graves, its people have Mongoloid features and belong to another racial type compared to the Afanasievo population. The Okunevo community was probably formed on the basis of local Neolithic groups. The tribes of Okunevo culture existed in the depressions of southern Siberia where the climate around 4500–4200 cal BP (2550–2250 cal BC) was more humid than in neighboring regions. The freshwater lakes increased in size, and the diversity of fauna grew; thus, the surrounding landscapes were suitable for hunting and fishing.

The climatic conditions changed at ~4000 cal BP (~2050 cal BC); in western Siberia the temperature increased. Climate remained sufficiently humid but became warmer. Climatic conditions in the Minisinsk and Turano-Uyuk depressions were drier than in the Nazarovo depression. It is necessary to note that most of the sites belonging to Andronovo culture of the Middle Bronze Age and dated to 3750–3350 cal BP (1800–1400 cal BC) were excavated first in the Nazarovo depression. In Minusinsk depression, less Andronovo sites were found, and only in its northern part. The time span for this culture in the Minusinsk depression ranged from 3720–3560 cal BP (1770–1600 cal BC) to 3450–3350 cal BP (1500–1400 cal BC). Andronovo sites were not found in the Turano-Uyuk depression.

The majority of studies suggest that the Andronovo culture belongs to the Indo-Europeans. This population moved from the north to Nazarovo depression around the Kuznetsk Alatau Mountains. According to Koryakova and Epimakhov (2007), the Andronovo culture (or cultural family) is represented by a great variety of settlements and burial grounds, and it is composed of several cultural lines of evolution: Petrovka-Sintashta (2000–1600 cal BC), Alakul' and Fedorovo (1500–1300 cal BC), and Sargary-Alexeevka (1200–1000 cal BC). It is traditionally accepted that the economy of the Andronovo culture was based on animal husbandry supplemented by some agriculture, hunting, fishing, and gathering. Andronovo stockbreeding is similar to that of eastern Europe with regard to herd composition. By this time, metallurgy was advanced and concentrated in centers of western Asia (the Urals, Kazakhstan, western Siberia, and the Altai Mountains), and metal production was surprisingly uniform throughout entire region. In the Yenisei River valley, the final stage of this culture dates to 3350–3250 cal BP (1400–1300 cal BC). The favorable humid climatic conditions very likely were responsible for the penetration of Andronovo tribes in the hard-hitting areas of southern Siberia. The Nazarovo depression was more suitable for their occupation, but the Minusinsk depression was settled only in the northern part. Both the southern part of the Minusinsk depression and the Turano-Uyuk depression are characterized by an arid climate at that time. The dry steppes were not suitable for farming, which has a high profile for Andronovo society. It is possible in this case that the choice of landscape played a vital part.

The Karasuk culture replaced the Okunevo culture in the southern part of southern Siberia and the Andronovo culture in the northern districts. In the Turano-Uyuk and Minusinsk depressions, the Karasuk culture appeared at the same time, around 3410–2740 cal BP (1460–790 cal BC). The climate in the depressions in this period was warm and moderately dry. The Karasuk was one of the most outstanding complexes of Late Bronze Age in southern Siberia and central Asia. Thousands of burial mounds and settlements were discovered in the steppe zone. In the Nazarovo depression, humid conditions continued during this period, but temperatures decreased. The first sites of the Karasuk-Irmen culture in this area are dated to 3250–3050 cal BP (1300–1100 cal BC). The diverse types of this culture developed from central Kazakhstan to Mongolia and northern China. The Karasuk people have both Mongoloid and Europeoid features. Nomadic cattle-breeding prevailed in their economy. The vast steppe areas and temperate climate attracted the nomadic tribes in the southern districts of southern Siberia. It is very likely that some of them came to this territory from southwestern regions.

A decrease in temperature is registered throughout the region at ~2800 cal BP (~850 cal BC), and corresponds to an increase in humidity. The steppes of intermountain depressions turned into excellent pasture landscapes. This time period corresponds to the expansion of nomadic Scythian cultures. They began to occupy this territory during the 1st millennium BC. In the Minusinsk and Nazarovo depressions, the Tagar culture developed at 2750–2680 cal BP (810–730 cal BC). At the same time, the Turano-Uyuk depression was occupied by the tribes of Aldi-Bel' culture.

Viewing these processes in light of global climatic changes allows us to distinguish some short and rapid cold climatic events during the Early–Middle Holocene in southern Siberia. In contrast to Europe where during these cold episodes very dry conditions existed (see Perry and Hsu 2000; Brooks 2006), in the majority of southern Siberian depressions the moisture increased. This is especially distinct in the southern part of the area and probably was connected to the characteristics of air flows. The Westerlies significantly influenced the climate. As a result of these types of climatic changes, the auspicious ecological niches developed in the intermountain steppe zones, the landscapes of which were not always suitable for human occupation. There is strong correlation between climatic changes and intensity of existence of humans. Some Neolithic sites are attributed to the period of 8200–5800 cal BP, and they are located mainly in piedmonts. Around 5300 cal BP, this territory was occupied by tribes of the Early Bronze Age. Around 4100 cal BP, the development of Early Bronze Age cultures and the appearance and expansion of Middle Bronze Age cultures is recorded. It is necessary to note that humid conditions controlled the processes of occupation and migrations of prehistoric people. The wettest conditions in this area at ~2800 cal BP resulted in the development of land suitable for pastures throughout the steppe zone and in the resulting expansion of Scythian nomadic tribes.

CONCLUSION

The complexity of the southern Siberian terrain, the division into depressions by mountain ridges, influenced the climatic differences. During cold events, the humidity increased from the more open northern areas to the southern areas. The southern depressions stayed drier in comparison to the northern depressions during the Early–Middle Holocene. The reconstruction and chronology of these events with the help of ^{14}C dating allows us to establish the connection between climatic factors and the appearance, development, and migrations of prehistoric people in the studied region.

The prehistoric peoples reacted to climatic changes because their existence depended on landscape-climatic factors. They adopted and occupied the most favorable land with respect to economic activities. The northern depressions with more humid conditions were occupied more intensively, and as a result they are characterized by more diversity of archaeological cultures.

The analysis of global environmental changes, with the help of a calendar timescale derived from ^{14}C data, allows the possibility of correlating the most significant climatic events with the local climatic variations and the estimation of their influence on the formation of different landscape zones. It can be assumed that the global climate changes were some of the important factors controlling the development of prehistoric people. This is important for understanding occupation processes, development, and migrations of ancient societies in different parts of southern Siberia and neighboring regions. More research is needed to uncover the details of this process.

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